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Description

Passive microphone with wireless transmission

The present invention relates to a microphone for detecting acoustic signals, converting the acoustic signals into electrical signals and transmitting the electrical signals to a receiving unit.

Known microphones of this type are usually supplied with power via a connecting line or a cable, respectively, via which the electrical signals are transmitted to the receiving unit, or have active electronic components and their own power supply in the form of a battery. Microphones in which the electrical signals are transmitted to a receiving unit via a wireless type of transmission, for example radio microphones, must have their own battery or their own accumulator which provides the necessary power for signal processing and signal transmission.

The receiving unit is, for example, a telephone base station which is connected to a landline network, but can also be a mobile station of a wireless telecommunication system. If the microphone is integrated in a headset, a cable link between the headset and the telephone base station is disadvantageous in many applications due to the restriction of the freedom of movement. In patent specification 195 20 674, therefore, it is proposed to send signals of a piezoelectric sensor to an evaluating device. In this case, however, it must be assumed that the transmitter has its own power supply. However, providing the microphone of the headset with its own power supply in the form of a battery is too much to ask of a user because of the increase in weight. In hands-free systems in motor vehicles, for example, neither of the

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two known solutions is practicable because, on the one hand,

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piezoelectric device for receiving and storing excitation energy from the receiving unit and for wirelessly transmitting electrical signals, converted from detected acoustic signals, to the receiving unit.

Using a piezoelectric device makes it possible, on the one hand, to receive and store excitation energy from the receiving unit and, on the other hand, to wirelessly transmit electrical signals bearing sound information to the receiving unit which provides for a simple and lightweight construction of the microphone according to the invention. Storing excitation energy in the piezoelectric device dispenses with the necessity of providing the microphone with its own power supply in the form of a battery or an accumulator.

The microphone according to the invention is a passive microphone, i.e. it is not provided with its own power supply and the transmission of electrical signals bearing sound information from the microphone to the receiving unit is carried out by means of continuous or discontinuous power transmission in the form of an electromagnetic signal by means of the receiving unit. The microphone according to the invention is thus constructed



The piezoelectric device advantageously stores the excitation energy from the receiving unit in the form of mechanical vibrations. Furthermore, a particularly lightweight and simple construction can be achieved if the piezoelectric device is used, at the same time, for storing the electromagnetic excitation energy, for detecting acoustic signals and for converting detected acoustic signals into electrical signals bearing sound information. In this case, the passive microphone according to the invention essentially only comprises the piezoelectric device, as a result of which a particularly simple, lightweight and inexpensive construction is possible. The piezoelectric device can, therefore, essentially consist, for example, of a piezoelectric diaphragm. The excitation energy from the receiving unit is then absorbed via the antenna of the microphone and converted into mechanical vibrations of the diaphragm. At the same time, the vibrating diaphragm can detect acoustic signals which are also modulated as mechanical vibrations onto the vibrations of the diaphragm caused by the excitation energy. The modulated vibrations are converted into electrical signals by the piezoelectric diaphragm and transmitted to the receiving unit. The piezoelectric diaphragm can consist of crystal or of lithiumniobate. Crystal, in particular, has a very high Q factor as energy store. As an alternative to the piezoelectric diaphragm, the piezoelectric device can essentially consist of a surface acoustic wave delay line or also of a resonator. In these embodiments, too, a single device is thus used for storing the electromagnetic excitation energy, for detecting acoustic signals and for converting detected acoustic signals into electrical signals bearing sound information, as a result of which a simple construction is possible.

As an alternative to constructing the piezoelectric device essentially of a single element, the piezoelectric device can comprise a device for detecting acoustic signals and a device for storing the electromagnetic excitation energy and for converting detected acoustic signals into electrical signals bearing sound information. Separating the functions into two different elements makes it possible to achieve greater sensitivity and better transmission quality. The device for detecting the acoustic signals can essentially consist, for example, of a diaphragm, advantageously of metal. The device for storing the electromagnetic excitation energy and for converting detected acoustic signals into electrical signals bearing sound information advantageously consists of a piezoelectric element such as, for example, a surface acoustic wave delay line or a resonator such as, for example, a piezoelectric diaphragm. The diaphragm for detecting acoustic signals can be bonded, for example, to the piezoelectric element, that is to say, for example, to the surface acoustic wave delay line or to the resonator, in order to be able to modulate the detected sound signals converted into mechanical vibrations directly onto the vibrations in the piezoelectric element which are caused by the excitation energy of the receiving unit. The modulated vibrations are then converted into electrical signals by the piezoelectric element and are transmitted to the receiving unit.

Furthermore, it is of advantage in the two embodiments above if one or a further device for detecting acoustic signals is provided and is arranged in such a manner that the detected acoustic signals are differentially converted into electrical signals bearing sound information. As a result, the sensitivity of the microphone according to the invention can be considerably enhanced. Furthermore, it is of advantage if a device for compensating for

disturbance variables is provided in order to compensate, for example, for the influence of temperature fluctuations or the like.

The electromagnetic excitation energy from the receiving unit can be transmitted to the piezoelectric device of the microphone according to the invention in the form of discontinuous or continuous excitation signals. The piezoelectric device can be designed in such a manner that it receives the electromagnetic excitation energy from the receiving unit in the form of short high-frequency signals. The electromagnetic excitation signals from the receiving unit can also be periodically repeated high-frequency signals. It is also of advantage if the piezoelectric device receives the electromagnetic excitation energy from the receiving unit in the form of excitation signals having a large bandwidth-time product. As an alternative, it may be of advantage if the piezoelectric device receives the magnetic excitation energy from the receiving unit in the form of a continuous frequency-modulated excitation signal.

In the text which follows, the present invention will be explained in greater detail by means of a preferred exemplary embodiment, referring to the attached drawings, in which

Figure 1 shows a diagrammatic representation of a microphone according to the present invention and an associated receiving unit, and

Figure 2 shows an exemplary embodiment of a piezoelectric device according to the invention.

Figure 1 diagrammatically shows a passive microphone 1 according to the present invention and a corresponding receiving unit 6. The passive microphone 1 according to the invention comprises a piezoelectric device 4 for receiving and storing excitation energy from the receiving unit 6

and for wirelessly transmitting electrical signals converted from the detected acoustic signals to the receiving unit 6. In the exemplary embodiment shown, the piezoelectric device comprises a device 2 for
5 detecting acoustic signals and a device 3 for converting the detected acoustic signals into electrical signals bearing sound information. The microphone 1 also exhibits an antenna 5, connected to the piezoelectric device 4, for receiving the
10 excitation energy from the receiving unit 6 and for sending out the electrical signals bearing sound information to the receiving unit 6.

The receiving unit 6 also comprises an antenna 7 for sending out the excitation energy in the form of
15 excitation signals and for receiving the electrical signals from the microphone 1.

As is shown in figure 1, the receiving unit 6 transmits the excitation energy, for example in the form of discontinuous excitation pulses, to the
20 microphone 1. The excitation pulses are received by the piezoelectric device 4 of the microphone 1 via the antenna 5 and are stored, e.g. as mechanical vibrations. For this purpose, the piezoelectric device 4 comprises, for example, a piezoelectric element as is
25 shown in figure 2. The piezoelectric element consists of a piezoelectric diaphragm 8 on which, for example, reflectors 10 consisting of deposited metal strips are provided.

Furthermore, a converter 9, which is coupled to
30 the antenna 5, for converting the received excitation pulses into a surface acoustic wave is provided on the diaphragm 8. The converter 9 is connected to a ground. Similar to the reflectors 10, the converter 9 consists of metal patterns, e.g. of aluminum, applied to the
35 diaphragm 8.

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When a high-frequency excitation is received from the receiving unit 6, the diaphragm is excited into vibrations via the converter 9 due to the formation of a surface acoustic wave. The vibrations expand on the top of the diaphragm in both directions toward the reflector fields 10 and are reflected by these so that a standing wave is formed in the case of resonance. In this manner, the excitation energy of the excitation pulse from the receiving unit 6 is stored in the form of mechanical vibrations. The piezoelectric element reflects the energy temporarily stored as mechanical vibrations back to the receiving unit 6 in the form of a decaying vibration via the antenna 5 as shown diagrammatically in figure 1. This decaying vibration is received in the receiving unit 6 via the antenna 7, and is detected, demodulated and analyzed.

The resonant frequency of the piezoelectric element and thus of the decaying vibration, which is reflected back to the receiving unit 6 by the piezoelectric element, changes under the influence of a strain because the speed of propagation of the surface acoustic wave and the distances between the two electrodes of the converter 9 change. In the embodiment shown in figure 1, the diaphragm 8 with the reflectors 10 is used as the device 3 for storing excitation energy from the receiving unit 6 and for converting the detected acoustic signals into electrical signals bearing sound information. The device 2 for detecting acoustic signals can be formed, for example, by a diaphragm, not shown, advantageously of metal, which is bonded to the diaphragm 8. The diaphragm used as the detection device 2 absorbs sound waves and converts them into mechanical vibrations. The mechanical vibrations are transferred from the diaphragm detecting the acoustic signals to the piezoelectric diaphragm 8. In this process, corresponding vibrations of the vibration of the piezoelectric diaphragm 8 caused by the electromagnetic excitation from the receiving unit 6 are

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5 As an alternative to the piezoelectric diaphragm 8 with the reflectors 10 and the converter 9, shown in figure 2, a surface acoustic wave delay line can be used as the device 3 for storing electromagnetic excitation energy from the receiving unit 6 and for
10 converting the detected acoustic signals into electrical signals bearing sound information. In a surface acoustic wave delay line, electromagnetic excitation energy from the receiving unit 6 is also stored as mechanical vibration. A detection device 2
15 for detecting acoustic signals, which is coupled to the surface acoustic wave delay line, converts received acoustic signals, i.e. sound waves, into mechanical vibrations which are transferred to the surface acoustic wave delay line. This causes transit-time
20 effects in the mechanical vibration caused by the excitation energy from the receiving unit 6, as a result of which the acoustic signals are modulated onto this mechanical vibration.

The acoustic signals detected by the device 2
25 are thus converted into electrical signals bearing
sound information by the device 3 and modulated onto
the piezoelectric element so that the decaying harmonic
vibration reflected back bears the sound information
modulated on. This sound information modulated on can
30 be detected and analyzed in the receiving unit 6.

It is particularly advantageous if the piezoelectric device 4 combines the devices 2 and 3 in one element which both detects the acoustic signals and

also converts the detected acoustic signals into electrical signals bearing sound information. The piezoelectric diaphragm 8 with the surface acoustic wave resonance pattern, shown in figure 2, is used as the single element forming the device 4. In this case, the piezoelectric diaphragm 8 detects incoming acoustic signals in the manner of a pressure sensor. The standing wave in the piezoelectric element, which is excited by an excitation pulse from the receiving unit 6, is modulated by the acoustic signals so that the decaying vibration reflected back to the receiving unit 6 after the end of the excitation pulse bears the corresponding sound information. This makes it possible to provide a very rugged passive microphone for wireless transmission of sound information which has a simple and lightweight construction.

The microphone 1 according to the invention is constructed as a passive component, i.e. without its own power supply in the form of a battery or the like, since the energy of the excitation pulses from the receiving unit 6 is absorbed by the piezoelectric element, is stored and is used for transmitting the sound information.

To avoid heterodyning of the excitation signals with the signals bearing the sound information, transmitted by the microphone 1, the piezoelectric element is excited discontinuously, for example by a pulsed excitation signal. However, it is also possible to find advantageous continuous excitation signals. An impulse response in the form of a decaying vibration, which is extended over a very long period in the time domain, is generated, and transmitted back to the receiving unit 6, in particular, if the diaphragm 8 is a crystal diaphragm which has a very high Q factor.

Furthermore, the piezoelectric diaphragm 8 can essentially consist of lithiumniobate.

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Instead of the piezoelectric diaphragm 8 with the surface acoustic wave resonant pattern, shown in figure 2, a surface acoustic wave delay line can also be used as the single element of the device 4. The
5 surface acoustic wave delay line can both detect the acoustic signals and convert the detected acoustic signals into electrical signals bearing sound information.

If the piezoelectric device 4 is used for
10 detecting the acoustic signals, a second piezoelectric device can be provided in order to provide for differential processing and conversion of the detected acoustic signals and thus to increase the sensitivity, for example for compensating for temperature
15 fluctuations. If a separate device 2 for detecting acoustic signals is provided, a second device 2 for detecting acoustic signals can be provided in order to provide for differential conversion of the detected acoustic signals into electrical signals for the same
20 purpose. In addition or as an alternative, a device for compensating for further disturbance variables can also be present.

As is shown diagrammatically in figure 1, the electromagnetic excitation energy can consist of
25 discontinuous excitation pulses which are sent out by the receiving unit 6 and are correspondingly received by the microphone 1 according to the invention. The excitation pulses from the receiving unit 6 can be, for example, short high-frequency signals which, if
30 necessary, are periodically repeated. It is of advantage in this arrangement if the excitation signal from the receiving unit 6 has a large bandwidth-time product. Another possibility is to use continuous frequency-modulated excitation signals.

35 Since the passive microphone 1 according to the invention is constructed in a very lightweight and rugged manner, it can be attached, for example, to a

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spectacles frame. The antenna 5 of the microphone 1 can be formed, for example, by one of the earpieces of the spectacles or by the frame of one of the spectacle lenses. The microphone can be attached to the transition between the earpiece, used as antenna, and the spectacle lens frame. As an alternative, the microphone according to the invention can be attached to a holder which is detachably attached to the spectacle frame and which extends downward in the direction of the mouth of the wearer from the spectacle lens frame. In this case, the holder can be constructed as the antenna 5 of the microphone 1.

The passive microphone 1 according to the invention is also suitable for use in a wireless headset by means of which voice signals are transmitted to a telephone base station or a telephone mobile station. The microphone according to the invention can be constructed to be very lightweight and rugged which results in varied and specialized applications.

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